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LANDSCAPE PLANNING AND ECONOMIC VALUATION OF MANGROVE ECOTOURISM USING GIS AND GOOGLE EARTH IMAGE

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Abstract:

Ecotourism is an alternative for development and management of forest area that is expected to provide sustainable economic, cultural and social benefits to the surrounding community. The central components of ecotourism are the landscape and the people. This study aims to create spatial planning of mangrove ecotourism through the exploration of landscape potential in the form of biophysical element and to evaluate recreational and socioeconomic values of Bakau Mas Ecotourism, in Lubuk Kertang Village, Langkat Regency, North Sumatra, Indonesia. Travel cost method (TCM) was used to evaluate the economic value of ecotourism. The ecotourism planning activities comprise of the potential inventory, analysis, synthesis, concept planning, and create the design of the site using geographic information system (GIS) and Google Earth Image (GEI). Landscape planning was developed through the spatial distribution of mangrove forest ecotourism areas. To obtain the socioeconomic values, 51 questionnaires were collected from the visitors. The ecotourism area is provided with 42.20 ha and 11.46 ha of buffer area. The area is equipped with land routes such as trails and boardwalk about 3,628.89 meters and waterways about 1,721.23 meters was the access to interpret the mangrove ecosystem. The economic value of Bakau Mas ecotourism area was IDR 55,002,604.00/year (USD 3,929). These results indicated that the willingness to pay was decreased by increasing the entrance fee. The models estimated that the optimal ticket price was IDR 16,000.00/person (USD 1,14).

Keywords: *Mangrove forest, Ecotourism, Landscape planning, Travel cost method, Socioeconomic value*

1. INTRODUCTION

The ecotourism term was used by Hector Ceballos-Lascurain in 1983. Nature tourism or ecological tourism primarily denotes a trip to a relatively undisturbed or polluted natural place that aims to learn, admire and enjoy the scenery, vegetation and wildlife, a form of cultural manifestation of existing society, both from the past and the present. The definition of ecotourism essentially from the type of tourism that is responsible for the preservation of an unspoiled area, benefiting economically and maintaining cultural integrity for local communities [1].

Bakau Mas ecotourism is a new ecotourism destination that offers mangrove ecosystem as its appeal and community-based mangrove management, bringing mangrove and people together [2]. This ecotourism is located in Dusun II Paluh Tabuhan, Lubuk Kertang village, Langkat, North Sumatra, Indonesia. Mangrove forests on ecosystem that spans about 1,200 ha at the estuary of Meku River. Adeniran et al. [3] have reported that there are two critical components in ecotourism, namely landscape and people. Structuring a good view as well as exciting cultural and social elements will provide visitor satisfaction. Without landscape planning, the ecotourism will only become the victims of natural destruction rather than acceptance the benefit from nature in the future [4]. It has been suggested recently that ecotourism is an economic tool to promote mangrove conservation and environmental awareness [5].

Landscape architecture is a profession and science discipline that employs principles of art and the

physical and social sciences to the processes of environmental planning, design and conservation, which serve to make sure the long-lasting improvement, sustainability and harmony of natural and cultural systems or landscape parts thereof, as well as the design of outdoor spaces with consideration of their aesthetic, side and ecological aspects [6]. Landscape design is a project that increasingly needed by people, including in its development. It is necessary to combine art and technology especially by applying geographic information system (GIS) and Google Earth Image (GEI). The use of GIS in landscape planning will benefit mainly from geospatial data [7]. The uptake of data using GIS is remarkably slow in landscape architecture, and when utilized. It is often restricted to basic tasks of mapmaking and data access only [8]. There are at least three conditions in which GIS could be useful for landscape design research exploiting the integrating, analytical and graphical capacities i.e. a. GIS-based modelling: data acquisition and the description of existing and future landscape architectonic compositions in digital form; b. GIS-based analysis: exploration, analysis, and synthesis of landscape architectonic structures to reveal possible architectonic relationships; c. GIS-based visual depiction: representation of landscape architectonic compositions in space and time, in order to retrieve and communicate information and knowledge of the landscape design [9]. These operations have a high potential for measurement of relevant and new aspects of landscape architectonic compositions, as well as offering alternative ways of understanding the landscapes [8].

The method of travel expenses is a method used to estimate recreational value of a location or an object. This method is an indirect method of measuring non-market goods or services [10]. The travel cost approach uses transportation or travel expenses primarily to assess the environment on tourism objects. This approach assumes that the travel and time costs were sacrificed by tourists to the tourist attraction are considered to be the environmental value paid by the tourists [11].

The concept of ecotourism is to make tourism activities to earn income for the conservation area. Therefore, the economic assessment of a region is an essential point in the development and management of ecotourism. The real economic value of environmental services may not be reflected in market transactions because in reality there is no market yet to facilitate the operations of ecosystem

services [12]. But in this case, the economic information value obtained by performing the valuation of the area will significantly assist the manager in determining the tariff visit. By setting an accurate and acceptable price by the users of nature, tourism will be very helpful in resource management and development [13].

Despite several studies have been proposed that mangrove and coastal environment are suitable place for development of ecotourism [1-2, 5,10,12], however, a few studies focused on landscape approach of mangrove ecotourism. The present study therefore purposes to create spatial planning of mangrove ecotourism through the exploration of landscape perspective in the form of biophysical element and to assess the recreational and socioeconomic values of Bakau Mas Ecotourism, in Lubuk Kertang Village, Langkat Regency, North Sumatra, Indonesia.

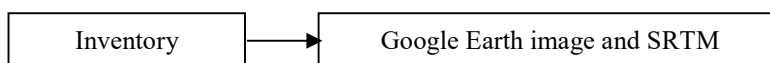
Travel cost method (TCM) was used to determine the economic value of ecotourism. The ecotourism planning activities involve the potential inventory, analysis, synthesis, concept planning, and create the design of the site using GIS and GEI.

2. MATERIALS AND METHOD

The data retrieval tool used is GPS, camera, Google Earth application, and the Shuttle Radar Topography Mission (SRTM) with high-quality digital elevation model (DEM) version 3. The data analysis tool used was ArcGIS 10.3. The economic value of local society was conducted with the questionnaire, Microsoft Excel, and PASW Statistic 18. This research comprises of inventory, analysis, synthesis, and landscape planning of Bakau Mas ecotourism as shown in Figure 1.

2.1 Landscape Planning

The design output of ecotourism planning was presented by GIS application to obtain detailed information about the spatial condition of the site. Landscape planning of proposed mangrove ecotourism activities in this study was illustrated in Figure 1. The threat and potential of ecotourism were synthesised as zone distribution and site planning to be area concept, circulation, conservation and site plan.



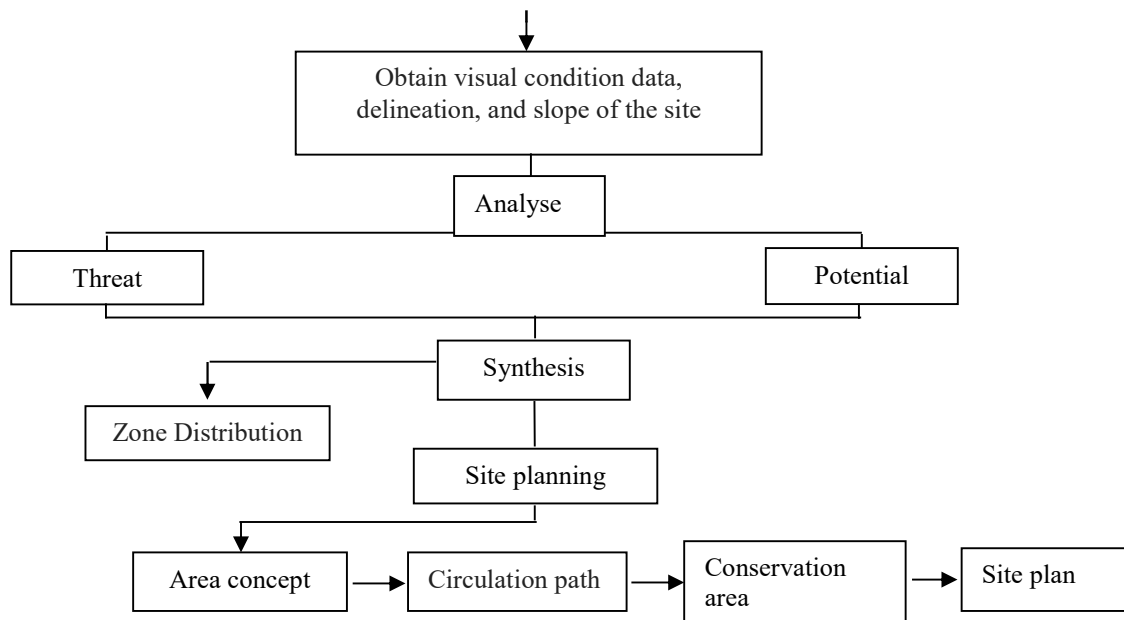


Figure 1: Flowchart of mangrove ecotourism for landscape planning

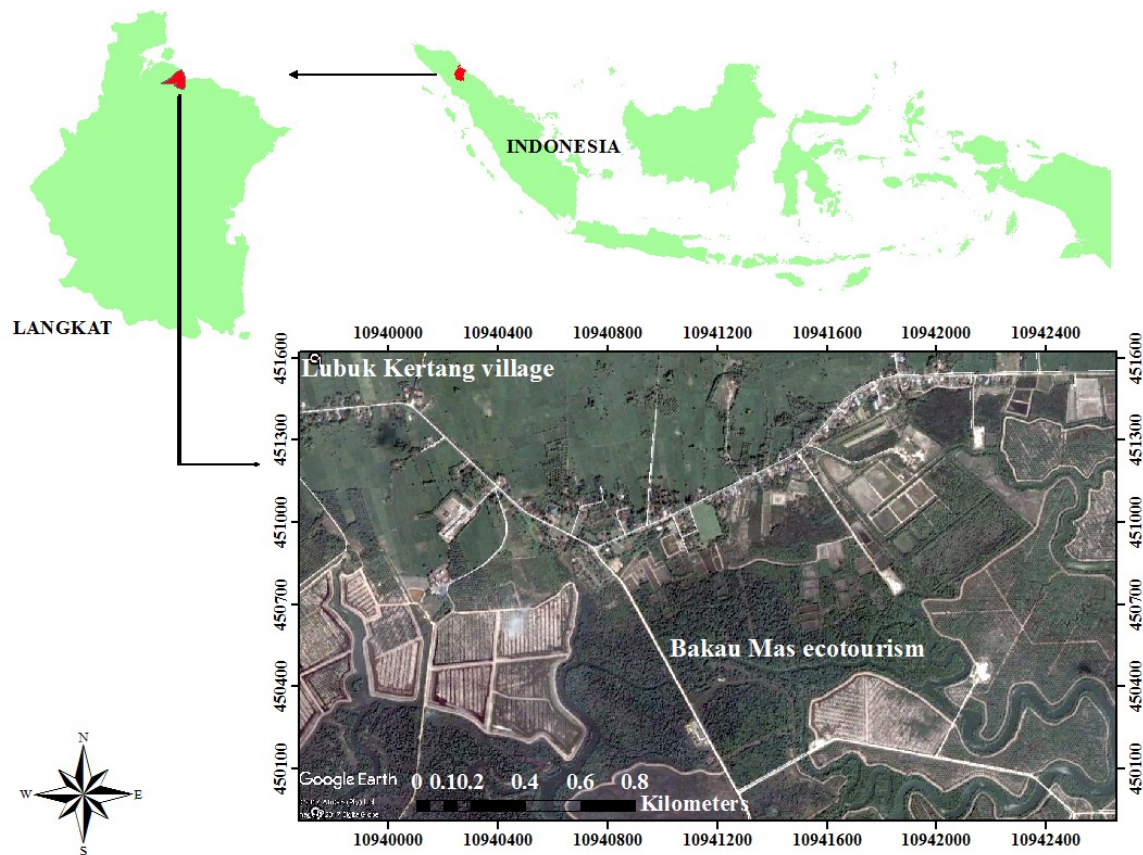


Figure 2: Map of research location

2.2 Economic Valuation of Mangrove Ecotourism using Travel Cost

To calculate the cost of travel was done in several stages as in [12] as follows:

2.2.1 Estimation of the number of visitors from each area of origin of visitors (zone) based on interviews with respondents

$$Z_i = P_i \times \Sigma Y \quad (1)$$

Note:

P_i : Percentage of visits from zone i

Z_i : Number of visitors from zone i

ΣY : Total number of visits

2.2.2 Determine the average travel cost of the total travel expenses incurred during travel or recreational activities

$$BPR = TR + D + KR + L \quad (2)$$

Note:

BPR: Average of travel cost (IDR/person)

TR: Transportation cost (IDR/person)

D: Documentation cost (IDR/person)

KR: Consumption cost during tourism

L: Others cost (IDR/person)

2.2.3 Definite average of travel cost zone- i

$$X_{li} = \Sigma B_{pi} / N_i \quad (3)$$

Note:

X_{li} : Travel cost from their origin area

B_{pi} : Travel cost from the result of taking a sample

N_i : Total of origin area population

2.2.4 Determine the rate of visits per 1000 person zone- i for a year

$$L_{ki} = \Sigma J_{pi} / J_{pt} \quad (4)$$

Information:

L_{ki} : Rapid of visitor visit in zone i

J_{pi} : Total of the visitor in zone i

J_{pt} : Total visitor population in zone i

2.2.5 Determine the economic value of tourism

Total willingness to pay (WTP) visitors is the area under the demand curve of the tourist services at the prevailing price level [12]. The demand curve of the economic value of tourism services as depicted in Figure 3.

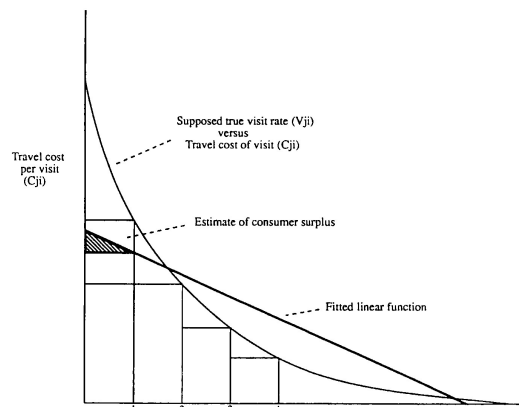


Figure 3: The demand curve for ecotourism economic value services

The economic value of nature tourism was determined by the formula:

$$NE = Pd + SK \quad (5)$$

Information:

NE: Economic value of nature tourism area

Pd : Income nature tourism area manager

SK: Consumer surplus

3. RESULTS AND DISCUSSION

Planning activities on conservation base are directed to three main components: site identification, design, and management [14]. The Previous study also stated that ecotourists satisfaction is influenced by physical attributes including tangible and intangible factors of tourism site, such as facilities and design [16].

The potential development of the site is done to improve the ecological function of the site to balance the ecosystem and to improve the aesthetics of the site which is the main attraction of ecotourism area. As described [17], ecotourism was understood and much more interesting with regarding five fundamental characteristics: it is based on the natural environment; ecologically sustainable; environmentally educative, locally beneficial (support, services and products (local employment), and tourist satisfaction. Potential and constraints inventory data of Bakau Mas ecotourism are available in Table 1.

Table 1. Potentials and constraints of mangrove ecotourism landscape

No.	Landscape Elements	Potential	Threat	Synthetic
1	Location and land use	The location is easy to reach and can be developed into several kinds of tours	The utilisation of the area as ecotourism has not been maximal in terms of space. The reception space for ecotourism activities is less extensive and less feasible.	Utilize resource wealth nature and the area by increasing the development of facilities and infrastructure of ecotourism activities
2	Accessibility	The road to the tread is good and can be passed either two wheels or 4 wheels or more	<ul style="list-style-type: none"> Roads are still compacted soil and gravel Some parts of the road are still affected by the tides There is no access to water tourism 	<ul style="list-style-type: none"> Roads are repaired by coating with asphalt or enhancing road bodies affected by tides with soil and gravel Creation of boat dock as an alternative visitor to cross the mangrove forest through the waterway
3	Topography and slopes	This ecotourism area is quite sloping, with a 2-15 m gradient class dominating the space	Most of the area is affected by tides	<ul style="list-style-type: none"> Establish road access that can be traversed despite the tide Limit the use of land affected by tidal water
4	Vegetation and animals	There are ten species of mangrove: <i>Avicennia marina</i> , <i>Avicennia lanata</i> , <i>Bruguiera sexangula</i> , <i>Rhizophora apiculata</i> , <i>Ceriops tagal</i> , <i>Xylocarpus granatum</i> , <i>Lumnizera racemosa</i> , <i>Sonneratia caseolaris</i> , <i>Excoearia agallocha</i> and <i>Acanthus ilicifolius</i> [17].	The structure of vegetation in some parts is disrupted due to exploitation before ecotourism activities are opened	Rehabilitate the forest mangroves in some locations experienced damage and organise other plants on the track access to the forest mangroves
5	Visitor	Visitor interest to the forest mangroves are seen in among students and Student college.	Lack of facilities Support of ecotourism.	Improved facilities facilities and infrastructure in supporting ecotourism for improve comfort and visitor interest to the mangroves forest.
6	Society	Society contribution against forest ecotourism development are high.	Knowledge society about ecotourism is still necessary improved.	Necessary counselling and training and empowerment in ecotourism activities.

3.1 Basic Concepts in Developing Ecotourism

Ecotourism is expected to provide experience and knowledge about mangrove ecosystem. The primary object of this ecotourism is the ecosystem as the habitat of flora and fauna. The making of planning process started from collecting the data that was processed in GIS. Visualization, spatial analysis, and spatial modelling are the most frequently used of GIS functions in plan making [8]. Remote sensing images are becoming an important source of spatial information for urban areas [9]. The area is divided into four regions, namely the reception area, the tourist service area, the tourist area, and the conservation area. Area division is determined by

visualisation of land cover and land contour. Land cover and land usage images obtained with GEIs are used as a consideration to establish the boundaries of ecotourism component areas. In addition to the previously mentioned area divisions, the determination of circulation or the road as a means of interpretation of the area is an important point. Site selection for the circulation path was determined by knowing the topographic information of the region. Contour information on the site will provide information on the steepness or flatness of the site. Furthermore the selection of land for ecotourism roads on flat and uniform soil conditions and preferably avoiding steep terrain as well as dense

vegetation site. Topographic information on a site three-dimensional solutions of a digital community was processed into three-dimensional spatial details refer to data collection, for managing the property with GIS. It provides the real spatial visual in all information, planning of buildings & roads, ground directions for watching the scheme objectively and lines, network service and investment exhibition making a good selection in an examination [19]. The [20].



Figure 4. Road placement on GEI in Bakau Mas ecotourism

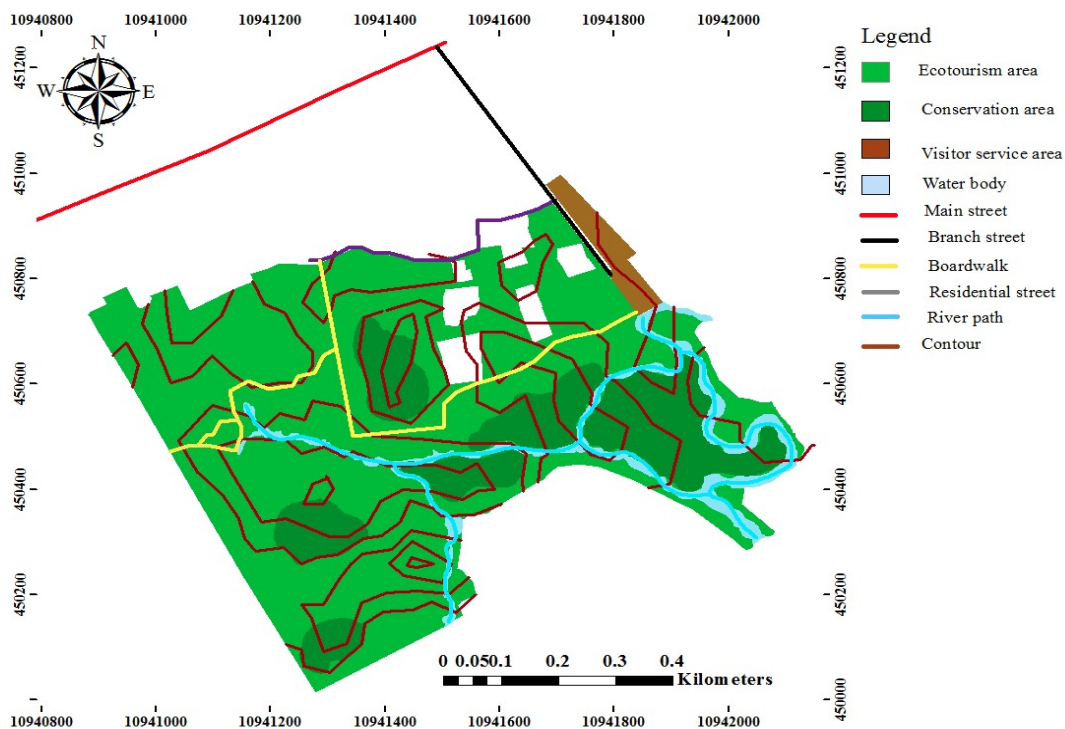


Figure 5. Map of area and roadmap based on contour on Bakau Mas ecotourism

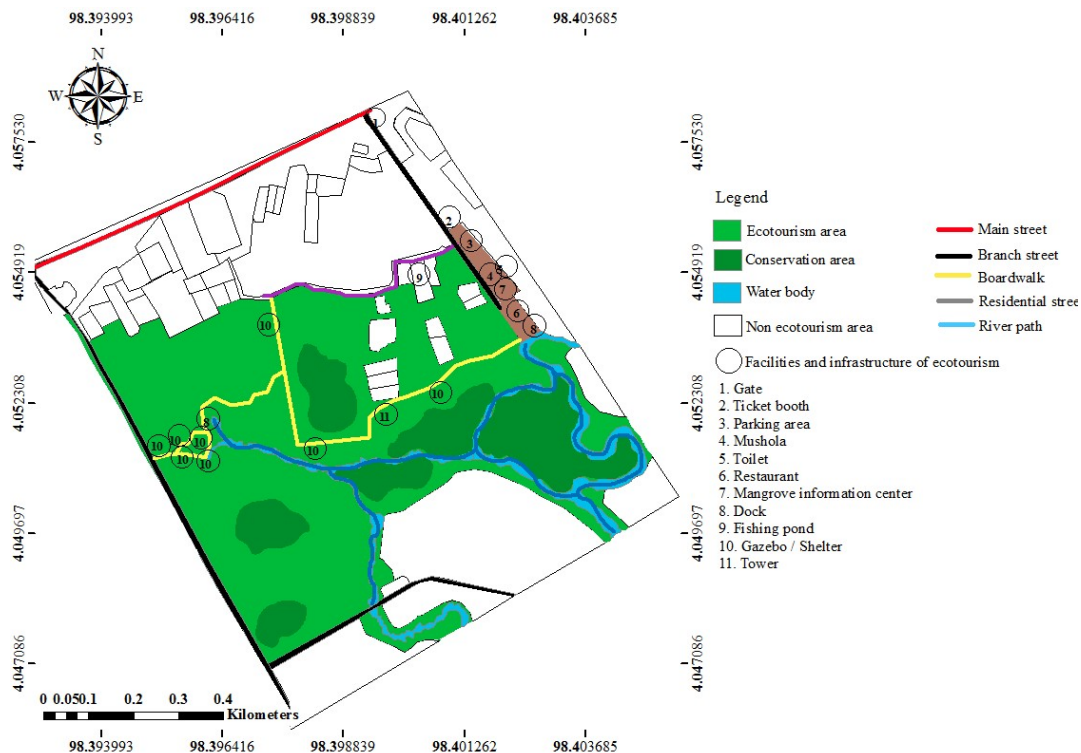


Figure 6. Map of the Mangrove ecotourism landscape plan

3.2 Reception Area and Circulation Path

The reception area is the first room visited by visitors. In the reception area is marked with a red line in Figure 4 starting from the intersection of the main road to the service area. Reception space is just a road that will be passed by visitors to reach the service room. Circulation path is the access that visitors use to achieve space in ecotourism activities. Circulation path in the surrounding ecotourism areas is vital to enable to explore [21]. Circulation paths are available on land and water routes. The type and length of the road are available in Table 2.

Visitor turnover begins with an interpretation through the boardwalk at the end of the service space marked by the yellow line in Figure 6. The boardwalk path of the plan is connected to the possible boardwalk pathways in the current state. At the end of the river, there is a dock to facilitate interpretation through the waterway. The boardwalk ends on the edge of the area and is connected by a path to get back to the service room. To interpret the navigation, there is a dock at the end of the service room. The waterway is marked with a blue line in Figure 6.

Table 2. Type and length of ecotourism route in Bakau Mas

Route type	Route length (meter)
Boardwalk	1.193
Foot trail route	510
River route	2.375
Total	4.078

3.3 Service Area

Service area serves as a preparation space for ecotourism activities. The service area is chosen for the former pond area and empty land which is located in the north of the ecotourism area. This area is preferred because it is close to the ecotourism area. The service area will be built some facilities and infrastructure that visitors can use as preparation for ecotourism activities which is one important aspect of tourism management. These infrastructures facilitate access, minimize impact, ensure visitor safety and enhance visitor satisfaction [4, 19]. Some facilities and infrastructure that will be built are as follows:

1. Ecotourism gate: the gate is built at the end of the entrance to the service room. The available road in the form of land can only load a vehicle. The road to the ecotourism area should be maintenance so as not to cause dust during drought or landslides during the

rainy season. For example, to resolve this matter by the application of paving blocks.

2. Parking lot: parking is directed to the first land in the service room. Based on the results of questionnaires of visitors who came to the ecotourism area as much as 63% using motorcycles, 25% using cars, and 12% using a bus or similar public vehicles. The parking lot should be divided into three lanes for each type of vehicle.

3. Mangrove information center: information center contains information and research on mangrove. Information on the area, activities and regulations and the safety of visitors in ecotourism was found at the information center.

4. Counter ticket: counter built about 50 meters after the entrance gate to facilitate visitors who will conduct ecotourism activities.

5. Praying/Mosque space: for visitors who want to perform worship activities provided mosque.

6. Restaurant: the restaurant is built to facilitate the needs of visitors after doing ecotourism activities or before ecotourism activities.

7. Toilet and restroom.

3.4 Conservation Area

Ecotourism has been expected can contribute to both conservation and development. The environmental protection has been recognised include as significant ecotourism benefits [22-23], therefore the ecotourism should have boundaries between protected areas and other land uses that affect both conservation priorities within protected areas and other priorities adjacent to them.

The conservation area is an area of protection against flora and fauna found in mangrove forests. The creation of buffers around ecologically fragile regions is important for ideal zoning on an ecotourist site [24]. The opportunities, focus and limitations for buffer zone development and management depend on many criteria and conditions. These are related to size, ecology, economy, legislation, social and institutional framework [25-26]. The land that uses for the conservation area is selected by the conditions of dense vegetation and tight contour line. The conservation area is provided with an area of 11.46 ha marked with dark green as shown in Figure 6.

3.5 Ecotourism Area

The ecotourism room is the space used for the main activities of the tour. The ecotourism space is 42.2 ha. This area is equipped with land routes such as trails and boardwalk along the 1,703 meters and waterways along the 2,375 meters as access to the interpretation of the mangrove area. As an interpretation for animals such as birds is provided

with the tower of view which is marked with the number 11 in Figure 6. The interesting of ecotourism activities is the presence of animals and plants [23]. These florae and fauna were essential factors of satisfaction [26], as also found in this ecotourism area.

The gazebo is provided as much as three pieces spread evenly in the ecotourism area plus five pieces on the conditions already available. Placement of the regulated gazebo has an optimal distance to each other. The gazebo is built with a size of 4 x 3 meters or 3 x 3 meters depending on field conditions. The fishing pond is provided on the former pond area marked no. 9 in Figure 6. The pond is located in the outermost position of the ecotourism area.

3.6 Description the Socioeconomic Condition of Visitors

The number of samples used in the economic assessment of ecotourism area was 51 people. People are also evident in the goals of ecotourism to bring benefits to local people and protect the natural and cultural heritage upon which the tourism is founded [4]. The age range of respondents was at the age of 13-16 (nine people), ages 17-26 (35 people), ages 27-36 as many as six people, and age 37-46 (one person).

Table 3. Tabulation of age and gender data of respondents

No.	Age Group	Number of Respondents	Percentage (%)
1	13 – 16	9	17
2	17 – 26	35	68
3	27 – 36	6	11
4	37 – 46	1	1

The highest education level of respondents was high school as many as 26 people then respondents with the level of education in college as many as 19 people. The least respondent is the level of junior high school education as many as six people where they are visitors coming from the village in the region of the ecotourism area.

Table 4. Tabulation of education level of respondents

No.	Level of education	Number of Respondents	Percentage (%)
1	Junior high school	6	11
2	Senior high school	26	50
3	College	19	37
Total		51	100

About 60% of respondents did not work; this circumstance due to most respondents are still

studying. As many as 19% of respondents have other types of work, 19% work as self-employed. The overall respondent stated that the purpose of the visit to conduct recreation activities and enjoy the tourism activities. The income level of respondents is dominated by respondents who do not have income as much as 33 people, followed by income level IDR 500,000.00 to IDR 2,000,000.00 (ten people) and at least one respondent had the income level above IDR 4,000,000.00. Income is also significant variable and has a positive relationship with willing to pay for visitors [25, 27]. The positive visitors' income indicated that willingness to pay the entrance fee increased with higher level among the visitors.

Table 5. Tabulation of occupation and income

No.	Type of work	Number of Respondents (people)	Percentage (%)
1	Entrepreneur	10	19
2	Others	10	19
3	No work	31	60
Total		51	100

No.	Income Level	Number of Respondents (people)	Percentage (%)
1	-	33	64
2	> IDR 500,000.00	1	1
3	IDR 500,000.00 – IDR 2,000,000.00	10	19
4	IDR 2,000,000.00 – IDR 4,000,000.00	6	11
5	> IDR 4,000,000.00	1	1
Total		51	100

1 IDR equal to 0.000075 USD

3.7 Number of Visits and Average Travel Cost

In the economic assessment of the Bakau Mas ecotourism area, the data were collected in the form of information from the visitors, the cost of return trips of visitors, the cost of consumption spent during ecotourism activities, the admission price of the area, as well as other costs such as parking fees, equipment rental fees, and documentation fees. The data were analysed to determine the value of ecotourism activities. Data on the results of the analysis of the area of origin of visitors, the total population of visitor areas, average travel costs and the rate of visits per 1000 population, and the average travel costs. Tables 6-7 summarised the data of value of ecotourism: visitors spending and visitors' origin, number of visitors, the rate of visits and average of travel costs.

Table 6. Percentage of visitor spending

No	Expenditure Type	Cost (IDR)	Percentage (%)
1	Transport	62,059	78.89
2	Consume	14,608	18.57
3	Entrance ticket	2,000	2.54
	Total	78,667	100.00

Table 7. Visitor data to obtain regression equation of tourism benefit value

N	Area of origin visitors	Visitors	Number of visitors (people)	Rate of visits	The average of travel cost (IDR)
1	Binjai	11	562	3	145,182
2	Medan	10	511	1	141,500
3	P. Tualang	5	256	6	42,000
4	Stabat	1	51	1	22,000
5	P. Susu	3	153	3	22,000
6	P. Brandan	10	511	23	30,700
7	Besitang	8	409	7	32,000
8	T. Pura	1	51	1	72,000
9	Gebang	2	102	3	33,500
	Total	51	2,607		

1 IDR equal to 0.000075 USD

Table 8. Number of visits at various entrance prices

N	Ticket price (IDR)	Visitor No	Income (IDR)	Total of willingness to pay (IDR)	Consumer surplus (IDR)
1	0	4,344	-	55,225,474	55,225,474
2	2,000	4,121	8,241,806	55,002,604	46,760,798
3	4,000	3,898	15,592,131	54,333,993	38,741,862
4	6,000	3,564	21,382,365	52,662,466	31,280,101
5	8,000	3,172	25,375,148	49,919,628	24,544,480
6	10,000	2,953	29,533,730	47,952,944	18,419,214
7	12,000	2,735	32,818,230	45,549,219	12,730,988
8	14,000	2,516	35,228,649	42,708,453	7,479,804
9	16,000	2,298	36,764,986	39,430,646	2,665,660
10	18,000	184	3,310,637	3,494,561	183,924
11	20,000	0	0	0	0

1 IDR equal to 0.000075 USD

Note: The blue letter showing the actual price entrance ticket, the red letter depicting optimum price for the ticket

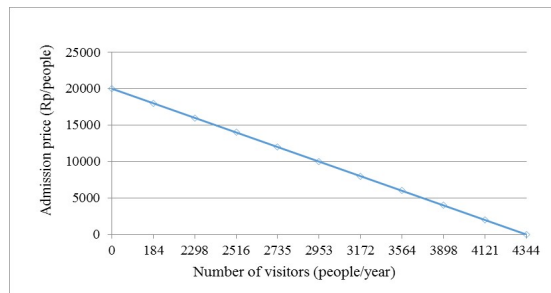


Figure 6. Mangrove ecotourism demand curve

Table 8 shows the simulation of a number of visits at various entrance fees. The price simulation starts from 0 to IDR 20,000.00 where the current ticket price is IDR 2,000.00. The price simulation stops at IDR 20,000.00 where the number of visits is 0. This was interpreted that at the price of IDR 20,000.00 no one is willing to visit the ecotourism area (Table 8, Figure 6). For the present price of IDR 2,000.00, the ecotourism area was just visited by 4,121 people with a consumer surplus of IDR 46,760,798.00 and the value of revenue coming to the manager of IDR 8,241,806.00 every year (Table 8). Where the value is only obtained from the sale tickets alone do not include other costs incurred by visitors in ecotourism activities. A number economic assessment of ecotourism areas with TCM have been reported [10-11, 14] as well as in this present study.

The calculation results showed that the management revenue would be maximum at the time of admission price of IDR 16,000.00/person with the estimated number of visitors reached 2,298 people/year (Table 8). Consumer surplus was the difference between the amount the buyer paid and the willingness to pay for a product [26]. The present results were consistent to the theoretical expectation as the given price was increased, the number of visitors willing to pay decreased, the same results also have been reported in the previous study of economic value for ecotourism in Puncak Lawang Park, West Sumatra, Indonesia [29]. This study suggested that the increase of entrance fee to enhance the conservation activity in ecotourism place.

Based on the data analysis, the economic value of Bakau Mas ecotourism area was obtained:

$$\begin{aligned}
 EV &= CS + \text{Income} \\
 &= \text{IDR } 46,760,798.00 + \text{IDR } 8,241,806.00 \\
 &= \text{IDR } 55,002,604.00/\text{year}
 \end{aligned}$$

1 IDR equal to 0.000075 US\$

This value is supposed to cover the maintenance of ecotourism and to develop it much better as well as conservation efforts.

The potential benefits of mangrove ecotourism have been proposed [2, 5], such as (1) increasing economic and livelihood diversification, (2) encouraging entrepreneurship (3) enhancing local community of skills and training, (4) maintenance of local culture and local wisdom, (5) empowerment of marginalized sections of the local community, and (6) increasing the local socioeconomic and environmental awareness of visitors. Therefore, mangrove ecotourism is regarded as a potential strategy to sustenance conservation of natural ecosystem as well as to promote the sustainable local development [30]. The concept of ecotourism reported in this study is dealing with protection of natural areas to provide generation of revenue, environmental education, and local involvement to contributing biological diversity and natural resources and economic growth and thus endeavours for mangrove sustainability [30].

Several factors influencing the success of ecotourism have been reported, for example, policies, management strategies, protected area employee duties, and characteristics of managers and employees [30]. However, in case of ecotourism in North Sulawesi for example in Bunaken, the relationship between ecotourism, local communities, and natural ecosystem area are not mutual for successful ecotourism [31]. It has been shown that benefits of local communities are few and the ecotourism sites are not well protected [31].

In addition, some recommendations have been described to balance between conservation of ecotourism and socioeconomic issue: understand the regional scope of ecotourism, use new social media, quantify the environmental effect, and integrate human and physical geography [5]. Recently, it has been reported that change of mangrove forests to other land uses such as aquaculture and oil palm plantation in Lubuk Kertang are major responsible for deforestation [32]. Therefore, the application landscape on mangrove ecotourism will meet the purpose of sustainable community based-mangrove management. Our present study revealed the first description on the landscape method using biophysical element and socioeconomic value as well as combined art and technology by applying GIS and GEI.

4. CONCLUSIONS

Landscape planning was developed by dividing the spatial area of mangrove forest. The ecotourism space was planned to be available in an area of 42.20 ha with a buffer area of 11.46 ha. Supporting facilities and infrastructure such as information

centers, ticket booths, toilets, and parking lots are located on the eastern side of the ecotourism area. There are three types of roads used as access to ecotourism activities such as walkways, boardwalk, and river paths.

The economic value of Bakau Mas ecotourism area was IDR 55,002,604.00/year. Through the calculation obtained the optimal ticket price of IDR 16,000.00. If the tariff of IDR 16,000.00 was applied, then the manager ecotourism will get income IDR 36,764,986.00/year. This revenue was used for ecotourism development and maintenance as well as regional conservation.

Our study confirmed that mangrove ecotourism in Lubuk Kertang, North Sumatra, Indonesia as tool for mangrove conservation, sustainable utilization, and increasing our knowledge of community-based mangrove management. The Implementation of mangrove ecotourism on the landscape suggested to provide socio-economic benefits to the local people through increasing local income, reducing fishing pressure, and contributing the environmental protection.

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